# Virginia City Hybrid Energy Center Response to Data Request Bruce Buckheit, Member, Virginia Air Pollution Control Board

Question (Page No. 19):

# **CO and HAZARDOUS AIR POLLUTANTS**

This is also true for the acid gas HAPs in the exhaust.

# **Response:**

The attached document (Attachment 1), Supplemental MACT Information Provided in Response to Comments (April 28, 2008), contains a comprehensive discussion of acid gas emissions, control, and compliance management.

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# ATTACHM T 1

# Virginia City Hybrid Energy Center

# **Supplemental MACT Information Provided in Response to Comments**

# 1.0 Supplement to Case-by-Case MACT Review, Introduction

In February 2008, the United States Court of Appeals for the D.C. Circuit granted petitions filed by State of New Jersey, et al, to vacate USEPA's decision to delist electric utility steam generating units (EGUs) as a source category under Section 112 of the Clean Air Act as well as the regulations under Section 111 of the Clean Air Act known as Clean Air Mercury Rule (CAMR) (United States Court of Appeals for the District of Columbia Circuit, Case No. 05-1097, Decided February 8, 2008). CAMR would have limited the allowable mercury emission rate from the proposed Virginia City Hybrid Energy Center's (VCHECs) two circulating fluidized bed (CFB) EGUs, allowed for its participation in a national mercury cap and trade program, and required continuous mercury emission monitoring.

Until such time as USEPA should properly delist EGUs or adopt a National Emission Standard for Hazardous Air Pollutants (NESHAP) for coal-fired EGUs under Section 112 of the Clean Air Act, proposed new EGUs that are a major source of hazardous air pollutants (HAPs), such as VCHEC, are subject to Clean Air Act Section 112(g), commonly referred to as case-by-case Maximum Available Control Technology (MACT). Congress listed the substances that are HAPs in Clean Air Act Section 112(b). In accordance with the applicable substantive requirements of 9 VAC 5-60-150 et seq. (Article 7), and the applicable procedural requirements of 9 VAC 5-80-1100 et seq. and 9 VAC 5-80-1400 et seq., Virginia Electric and Power Company, doing business as Dominion Virginia Power (hereinafter referred to as Dominion), submitted an application for an Article 7 Permit, including a case-by-case MACT analysis for the proposed EGUs at VCHEC. As demonstrated in that application, the proposed CFB boilers will employ MACT for each HAP that USEPA has associated with this source category. The analysis addressed mercury emissions, non-mercury metallic HAP emissions, inorganic acid gas HAPs (hydrogen chloride and hydrogen fluoride), and organic HAPs. This document has been prepared to supplement the original case-by-case MACT evaluation provided in response to comments, requests and inquiries from the Board and the public.

# 2.0 Determination of Case-by-Case MACT

Case-by-case MACT is defined in 9 VAC 5-80-1410(C) as:

"The emission limitation which is not less stringent than the emission limitation achieved in practice

by the best controlled similar source, and which reflects the maximum degree of reduction in emissions that the executive director, taking into consideration the cost of achieving such emission reduction, and any non-air quality health and environmental impacts and energy requirements, determines is achievable by the constructed or reconstructed source."

# 40 CFR 63.43(d) provides the principals of case-by-case MACT determination:

- (1) The MACT emission limitation or MACT requirements recommended by the applicant and approved by the permitting authority shall not be less stringent than the emission control which is achieved in practice by the best controlled similar source, as determined by the permitting authority.
- (2) Based on the available information, as defined in this subpart, the MACT emission limitation and control technology...recommended by the applicant and approved by the permitting authority shall achieve the maximum degree of reduction in emissions of HAP which can be achieved by utilizing those control technologies that can be identified from the available information, taking into consideration the costs of achieving such emission reduction and any non-air health and environmental impacts and energy requirements associated with the emission reduction.
- (3) The applicant may recommend a specific design, equipment, work practice, or operational standard, or a combination thereof, and the permitting authority may approve such a standard if the permitting authority specifically determines that it is not feasible to prescribe and enforce an emission limitation under the criteria set forth in Section 112(h)(2) of the Act.
- (4) If the Administrator has either proposed a relevant emission standard pursuant to section 112(d) or section 112(h) of the Act or adopted a presumptive MACT determination for the source category which includes the constructed or reconstructed major source, then the MACT requirements applied to the constructed or reconstructed major source shall have considered those MACT emission limitations and requirements of the proposed standard or presumptive MACT determination.

The emission limitation, or in the absence of a comparable emission limitation that control technology that is determined to be not less stringent than the emission limitation achieved in practice by the best controlled similar source is sometimes referred to as the "MACT Floor". The case-by-case MACT evaluation established a MACT floor for each HAP or category of HAP from the best controlled similar source(s). USEPA, in proposing a mercury NESHAP for EGUs, subcategorized coal-fired EGUs based on the rank of coal fired (e.g., bituminous, subbituminous, etc.) and proposed limits for IGCC units separately from CFB or PC units. See 69 Fed. Reg. 4652, 4662-63 (Jan. 30, 2004). USEPA did not propose a MACT Floor for other HAPs emitted from coal-fired EGU's, but acknowledged that for HAPs other than mercury subcategorization by boiler type might be appropriate.

VCHEC will burn a blend of fuels including bituminous coal, coal refuse and biofuels, a fuel blend that currently has only been used in CFB units for utility generation. Similar sources to the proposed VCHEC EGUs are therefore multi-fuel (eastern bituminous and waste coal) CFB boilers. The determination of case-

by-case MACT performed also considered levels of control beyond the MACT floor.

While no existing facility fires the exact fuel blend as the proposed VCHEC blend, there are facilities that fire bituminous or waste bituminous coal. These sources have been considered similar and were reviewed for the purposes of the MACT analysis. The sources that were reviewed and compared to VCHEC are listed in Table 1 below:

Table 1: Similar Sources to VCHEC

Project	State	Fuel		
AES Puerto Rico	(Puerto Rico)	Bituminous Coal		
Grant Town Power Plant	West Virginia	Waste Coal		
Greene Energy	Pennsylvania	Waste Coal		
Morgantown	West Virginia	Bituminous Coal		
North Branch	West Virginia	Bituminous Coal		
River Hill	Pennsylvania	Waste Coal		
Robinson Power Beach Hollow	Pennsylvania	Waste Coal		
Scrubgrass	West Virginia	Waste Coal		
Reliant Seward	Pennsylvania	Waste Coal		
Spurlock 3	Kentucky	Bituminous Coal & TDF		
Spurlock 4	Kentucky	Bituminous Coal & TDF		
Western Greenbrier	West Virginia	Waste Coal		

MACT limits also must be achievable, that is, they must be able to be met continuously under reasonably foreseeable worst-case conditions. See Sierra Club v. EPA, 167 F.3d 658, 665 (D.C. Cir. 1999). To ensure the MACT limits are continuously achievable, it is appropriate to include a margin of safety in the limit, particularly when basing a limit on limited data such as short-term stack test results. See, e.g., 69 Fed. Reg. at 4678 (describing approach EPA used in developing proposed MACT limits for new EGUs to address uncertainty and variability in emission test results). HAP emissions such as acid gases are directly related to the amount of the pollutant in the fuel, which varies even within the same fuel type. Short-term stack test results do not adequately account for that variability. Moreover, MACT is defined as "The emission limitation which is not less stringent than the emission limitation achieved in practice by the best controlled similar source" (emphasis added). The MACT Floor should therefore be established based on the lowest permit limit for which the best controlled similar source has demonstrated continuous compliance in practice, including consideration of the specific requirements for compliance demonstration, i.e. compliance period.

Thus, when evaluating data from a best controlled similar source to apply to VCHEC, it is not appropriate to infer that actual emission (stack test) data represents a basis for establishing a MACT Floor, as such spot tests are not continuously achievable under reasonably foreseeable worst-case conditions due to uncertainty and variability in fuels, control equipment operation and the conditions under which the data

were collected.

It is also important to note that due to the reversal of regulatory direction by EPA in 2005 resulting in CAMR and the subsequent litigation and vacatur of EPA's rules in 2008, there few EGUs that have emission limitations for HAPs and even fewer at which compliance with those limitations have been demonstrated in practice. Moreover, unlike the RBL Clearinghouse used for the determination of RACT, BACT and LAER, there is not yet a database for such information regarding MACT.

# 3.0 Expected HAP Emissions

The hazardous air pollutants (HAPs) that are expected to be emitted from the proposed VCHEC boilers were estimated from proposed case-by-case MACT emission limits for Hg, HCl and HF, from published fuel composition and control factors cited in "Study of Hazardous Air Pollutant Emissions from Electric Utility Stem Generating Units – Final Report to Congress," U.S. EPA, February 1998, and from USEPA AP-42, and are re-listed here for reference in Table 2. These may be subcategorized as either mercury, non-mercury metals, acid gas and organic HAPs. Mercury is unique among HAP metals in that it exists in vapor form at typical stack temperatures. All other HAP metals exist as solid particulate at stack temperatures, and are therefore controlled together with, and as a subset of, the criteria air pollutant category "filterable PM<sub>10</sub>". Organic HAPs are similarly a subset of the PSD pollutant category Volatile Organic Compounds (VOC), and are controlled together with non-HAP VOC. Acid gas HAPs (such as HF and HCl) are neutralized together with criteria pollutant acid gases such as H<sub>2</sub>SO<sub>4</sub> and SO<sub>2</sub>. The control technologies capable of achieving the maximum degree of reduction for mercury, PM<sub>10</sub>, acid gases and VOC from the best controlled similar sources (multi-fuel circulating fluidized bed boilers) were determined to represent the case-by-case MACT Floor for each category of HAP emissions.

Based on reasonable inquiry, Dominion determined that the primary HAPs from multi-fuel and coal-fired CFB boilers that are permitted are Hg, HCl, HF, and Pb, and therefore little publicly available emission data were identified for the majority of individual HAPs emitted from multi-fuel CFBs. For all similar multi-fuel CFBs, with the exception of Hg, HCl and HF, MACT has been demonstrated based on the application of the highest removal efficiency for each *category* of HAP.

As previously discussed, it is not appropriate to prescribe and enforce a MACT emission limitation based on limited stack tests of lowest actual emissions from one or more similar units without accounting for variability over time. Case-by-case MACT seeks to establish a level of control that can be reliably met all of the time. The HAP levels in coal as well as myriad other performance variables (for example fuel moisture content, heating value, boiler load, transient vs. base load operation, variations in sorbent properties and air pollution control system performance to name just a few) vary in real time. All identified historical HAP testing for multi-fuel CFB boilers has been performed based on a snapshot (typically 3-hr) stack test, performed once,

or at most a few times over the life of the facility. Performance stack tests under 40 CFR 60 Appendix B and 40 CFR 63 are always performed at or near full load, and always under steady state conditions. When an EGU fails a stack test, it is adjusted and retested to demonstrate compliance. Statistically, some stack tests will capture a low emission rate while others will capture a median or high emission rate. In every case, enforceable permit limits need to include a margin to ensure that continuous compliance can always be maintained every hour of every year under every operating condition. If a MACT limit were to be established for an existing similar source based on the lowest emission level that source had ever achieved, that unit would by definition be out of compliance with that limit at all other times of the year. Case-by-case MACT must acknowledge the limitations of statistically insufficient stack test data and account for the high level of variability in HAP emissions from this source category.

Mercury emissions from the proposed VCHEC multi-fuel CFB's were proposed based on continuous mercury monitoring. A MACT limit for Hg that is based on real-time continuous monitoring is by definition a more stringent standard (even if numerically equivalent) than one that is simply based on an initial performance test. No similar operating multi-fuel CFB was identified that has a MACT compliance limit requiring continuous monitoring. Therefore, stack test data from such a facility is of little value in determining an annual MACT limit for VCHEC that must be demonstrated with real-time measurements. Thus, the annual Hg MACT limit in the Draft Permit for VCHEC is not only lower than the MACT Floor (the lowest enforceable Hg limit for which continuous compliance has been demonstrated by any similar multifuel CFB) in terms of its equivalent rate of 0.00965 lb/GW-hr, but also because it will be the first known unit to operate with a Hg limit subject to continuous monitoring to demonstrate compliance.

The Hg limit established as case-by-case MACT reflects variability in coal properties (notably coal mercury content) that will be experienced by a multi-fuel CFB. Due to the high variability of coals and HAP contents (such as mercury), the comparison of percentage removal for any given HAP from one facility to another is useful as a basis for equipment design when normalized to a design basis fuel, but because of its inherent variability, it is not useful for establishing a MACT Floor. Percent HAP removal estimation based on EPA's generic factors that are presented in Table 2 are not relevant to the actual performance of the VCHEC boilers – they are simply published EPA estimates based on what is typical from the generation of CFB boilers that were operating in the years that EPA collected the data.

HAPs other than Hg, HCl and HF presented in Table 2 are a collection of many individual HAP species for which little or no test data is available to otherwise determine "the best level of control achieved in practice" from similar units. Due to the lack of statistically significant test data for multi-fuel CFBs, a combination of the specific design, equipment and operation standards were determined to reflect case-by-case MACT for these categories of HAP emissions, since in each case they are subsets or surrogates of a criteria air pollutant for which continuous or periodic monitoring is proposed to ensure optimal function of the MACT

control device. This combination of design, control equipment selection and compliance monitoring for related criteria air pollutants was determined to constitute case-by-case MACT for the non-mercury HAPs from the proposed multi-fuel CFBs.

Table 2 is simply a list of typical or expected HAP emission rates from a CFB boiler firing typical Virginia coal, and scaled to the output of the two VCHEC boilers (based on several USEPA sources as noted). Note that Table 2 does not take into account HAPs contained in coal that remain with or are captured within the process, and therefore percent removal values reported across a control device do not necessarily reflect the total percent reduction from fuel HAP content. This summary was used to provide a conservative estimate (conservative because the data were compiled from an earlier generation of CFB technology) of annual HAP emissions, but with the exception of Hq, HCl and HF (which are based on actual limits) is in no way specific to the actual HAP emissions expected from the proposed VCHEC boilers. By virtue of employing the same or better control technologies (in-situ desulfurization with polishing spray dryer absorber, powdered activated carbon Hg sorbent injection followed by fabric filter) employed by the best performing similar source(s), the actual HAP emissions from the VCHEC boilers will exhibit the same actual levels of control being achieved in real time for each category of HAP as the best performing similar source(s). A table (Table 5) of HAP emission limits for the similar sources in Table 1 is presented at the end of this document for comparison purposes. The table includes emission limits for PM (surrogate for inorganic HAPs except for Hg), CO and VOC (surrogates for organic HAPs), HCl, HF, and Hg, as well as specific organic or inorganic HAPs, if any.

Table 2: Estimated Tons Per year of HAP Emissions

Emission Point	HAP Emitted	Uncontrolled HAP Emissions (tpy)	Controlled HAP Emissions (tpy)	Control Technology <sup>a</sup>
CFB1	Mercury Compounds <sup>b</sup>	0.62	0.012	FGD/FF/ACI
	Hydrogen Chloride <sup>c</sup>	1,810	36.25	LI/FGD/FF
	Hydrogen Fluorides <sup>d</sup>	1,596	6.45	LI/ FGD/FF
	Antimony Compounds <sup>e</sup>	1.7	0.005	FF
	Arsenic Compounds <sup>e</sup>	14.9	0.0300	FF
	Beryllium Compounds <sup>e</sup>	3.1	0.004	FF
	Cadmium Compounds <sup>e</sup>	0.023	0.001	FF
	Chromium Compounds <sup>e</sup>	10.1	0.203	FF
	Cobalt Compounds <sup>e</sup>	11.1	0.011	FF
	Manganese Compounds <sup>e</sup>	32.8	0.065	FF
	Lead Compounds <sup>e</sup>	107	0.107	FF
	Nickel Compounds <sup>e</sup>	13.25	0.15	FF
	Selenium Compounds <sup>e</sup>	4.0	0.04	FF
	Organic HAPs	2,448	24.48	GCP/FF/ACI
CFB2	Mercury Compounds <sup>b</sup>	0.62	0.012	FGD/FF/ACI
	Hydrogen Chloride <sup>c</sup>	1,810	36.25	LI/FGD/FF
	Hydrogen Fluorides <sup>d</sup>	1,596	6.45	LI/ FGD/FF
	Antimony Compounds <sup>e</sup>	1.7	0.005	FF
	Arsenic Compounds <sup>e</sup>	14.9	0.0300	FF
	Beryllium Compounds <sup>e</sup>	3.1	0.004	FF
	Cadmium Compounds <sup>e</sup>	0.023	0.001	FF
	Chromium Compounds <sup>e</sup>	10.1	0.203	FF
	Manganese Compounds <sup>e</sup>	32.8	0.065	FF
	Cobalt Compounds <sup>e</sup>	11.1	0.011	FF
	Lead Compounds <sup>e</sup>	107	0.107	FF
	Nickel Compounds <sup>e</sup>	13.25	0.15	FF
	Selenium Compounds <sup>e</sup>	4.0	0.04	FF
	Organic HAPs	2,448	24.48	GCP/FF/ACI

a. LI means furnace limestone injection, FGD means dry flue gas desulfurization, FF means fabric filter baghouse, GCP means good combustion practices, and ACI means activated carbon injection.

b. Beyond the MACT Floor for Hg. Equivalent to  $\sim$  9.0 E-7 lb/MMBtu

c. Proposed HCl case-by-case MACT limit of 0.0026 lb/MMBtu.

d. Proposed HF case-by-case MACT limit of 0.0047 lb/MMBtu.

e. Generic EPA estimates based on fuel composition and control factors cited in "Study of Hazardous Air Pollutant Emissions from Electric Utility Stem Generating Units – Final Report to Congress," U.S. EPA, February 1998.

# 4.0 MACT Expressed as Outlet Limitations

In January 2004, EPA concluded "For development of a MACT Standard, EPA determined that an [Hg] emission limitation is the appropriate format to be used based on considerations with regard to available data, compliance options and consistency with other combustion rules". This determination was based on the consideration by USEPA whether MACT standards should be based on percent removal efficiency of HAP control systems, percent Hg reduction by best performing units, or outlet concentration expressed as an enforceable limit in developing a proposed MACT Floor for new coal-fired EGUs. Thus, MACT emission limits have been proposed for VCHEC as enforceable outlet emission levels that must be achieved regardless of HAP input levels for Hg, HCl and HF.

The equivalent Hg MACT level for the best controlled similar source was determined to be 0.028 lb/GW-hr (Spurlock Unit 3). The tpy Hg MACT limit in the Draft Permit for VCHEC is not only lower than the MACT Floor (the lowest enforceable Hg limit for which continuous compliance has been demonstrated by any similar multi-fuel CFB) in terms of its equivalent rate of 0.00965 lb/GW-hr, but also because it will be the first known unit to operate with a Hg limit subject to continuous outlet (stack) monitoring to demonstrate compliance.

MACT control technology has been specified for non-mercury metallic HAPS and organic HAPS, which are each a subset of the PSD regulated pollutants filterable PM and VOC. Thus, by requiring the top level of control for filterable PM and VOC, the design and performance of the air pollution control system equivalent to (or better than) the best controlled similar source for HAP metals and organic HAPs can be assured. The continuous monitoring of CO (another product of incomplete combustion) as required to meet PSD requirements may also be used as an indicator that good combustion is being continuously adjusted and maintained, however CO itself is not a HAP and is not subject to MACT. Organic HAPs are a subset of the regulated PSD pollutant VOC which is a more direct indicator of the furnace conditions that minimize emission of organic compounds.

# 5.0 Control Technologies Selection

The proposed Virginia City Hybrid Energy Center's circulating fluidized bed boilers will incorporate the best control technologies for each class of HAPs. These technologies include combustion of fuels within a bed or sorbent inherent to operation of CFB boilers followed by carbon (or other sorbent) injection upstream of a fabric filter for mercury control; fabric filter technology for control of metallic HAPs; combustion of fuels within a bed or sorbent inherent to operation of CFB boilers followed by a spray dryer absorber / fabric filter for control of acid gases; and good combustion practice (time, temperature and turbulence inherent to CFB boilers) to limit emissions of organic HAPs. These control technologies constitute the maximum degree of reduction, and therefore case-by-case MACT for each category of HAP expected to be emitted from the proposed VCHEC CFB boilers. This is a better combination of control technology than is used by the best

controlled multi-fuel CFB boilers (Dominion has not identified any other multi-fuel CFBs operating continuously with carbon injection and continuous Hg monitoring in the United States), and reflects the maximum degree of reduction in emissions from the proposed EGUs.

# 6.0 Selection of Case-by-Case MACT for the VCHEC Multi Fuel CFB Boilers

The operating efficacy of the various pollution control stages will be continuously assured due to requirements in the draft air permit to continuously monitor emissions of CO (a good indicator of proper combustion control), SO<sub>2</sub> (a good indicator of effective acid gas neutralization), filterable PM (a good indicator of fabric filter performance) and Hg. The combination of the use of continuously monitored surrogate performance indicators together with selection of the same or better control technology employed by the best controlled similar sources (in-bed desulphurization, selective non-catalytic reduction (SNCR), spray dryer absorber, activated carbon (or similar sorbent) injection and fabric filter) was used to establish case-by-case MACT for all HAPs emitted from the proposed VCHEC multi-fuel CFBs.

# 7.0 Evaluation of Coal Pre-Treatment Alternatives

# 7.1 Coal Washing

USEPA considered coal washing techniques during its development of a proposed MACT Floor for new coal-fired boilers in 2003. In a memorandum to Bill Maxwell of USEPA from Jeffrey Cole of RTI International entitled "MACT Floor Analysis for Coal- and Oil-Fired Electric Utility Steam Generating Units National Emission Standards for Hazardous Air Pollutants", December 2003, USEPA provides its evaluation of coal washing in regard to establishment of MACT Standards for new coal-fired units. That report states "Pursuant to current EPA policy, the development of all MACT standards must consider, as a potential MACT control strategy, any pollution prevention techniques that could reduce or eliminate the pollutants of concern from being produced by the process." EPA considered the use of different coals, including preprocessing (washing) and noted "In some cases, it was found that low-sulfur coal may actually result in an increase of some HAP, including Hg" (resulting from the removal of chlorine from the coal which tends to convert elemental mercury into an easier to capture particulate form). Due to these sometimes counterintuitive findings, USEPA ultimately determined that the specification of "low HAP coals" was not an appropriate factor in development of a MACT Floor for new coal-fired EGUs.

Analysis of the data collected by USEPA indicated that not all mercury contained in coal is created equal, citing differences in speciation of the mercury in the fuel as a major factor. According to USEPA "The data show that although a coal may have a lower Hg loading in the coal, the Hg emissions may be more difficult to control if that seam of coal tends to speciate to Hg to an elemental form." Dominion's understanding is that washing of Virginia coal may reduce its mercury content by 5-30% (depending on the seam, mining

technology, size distribution, differences in specific gravity, etc). The reason that washing can reduce mercury at all is that some of the mercury present in ROM coal is bound in the rock (rock mercury) that is separated from coal during washing (mercury contained in the structure of the coal itself is not believed to be affected by washing). Removal of up to 30% of the mercury content is dependant on a high percentage of pyritic material in the fuel. In the case of southwestern Virginia coals, there is not a high percentage of pyrites in the fuel.

Although coal washing can remove some mercury, it creates some adverse economic, energy and environmental impacts as well. Washed coal is significantly more expensive than ROM coal. The process of washing coal demands energy (energy required to wash the coal at the preparation plant as well as increased transportation, not to mention carbon lost in the washing process). The wet process of washing coal uses significant amounts of water. Finally, washing coal may remove some metals by removing the rock material prior to combustion, but that material is still placed back into the environment in a waste pile or slurry impoundment.

EPA also determined that mercury contained in rock is primarily released in the form of particulate mercury when burned in a CFB boiler, a form of mercury that is very effectively collected by a high efficiency baghouse. The "coal mercury", on the other hand, is substantially released as elemental mercury and much more difficult to capture. The data available to EPA when EPA developed the New Source Performance Standard for mercury emissions from coal-fired utilities resulted in a lower mercury limit for waste coal than for bituminous coal. This fact indicates that there are emissions trade-offs with washing coal. For instance, washing coal reduces chlorine content in the material, which would otherwise have served to help control mercury emissions.

Coal refuse, or waste coal, is known to contain a higher concentration of Hg per ton of coal than high Btu washed bituminous coals. This is presumably because the waste coal includes all of the rock that had been historically washed out of ROM coal. However, EPA determined that CFB units firing waste coal (including an extreme % of rock mercury) emitted substantially less Hg from their stacks than those burning high Btu Eastern Bituminous coals. EPA went on to propose a MACT Floor for boilers that burn waste coal that was lower than for units burning high Btu washed Bituminous coal.

Coal washing was also considered as a potential MACT candidate for reducing emissions of non-mercury metallic HAPs. Clearly waste coal and ROM coal will contain more inert rock than washed high Btu bituminous coal. This is not, however, expected to influence the actual emission of HAP metals from VCHEC. CFB boilers require a certain inventory of circulating inert material within which the fuel is combusted. In fact, CFB's that burn low ash fuels often have to add sand or some other inert material to make up the bed inventory. Bed inventory is lost when the particles abrade to a size distribution where they

are no longer collected for recycle by the hot cyclones and escape to the fabric filter for collection. Depending on the alkalie content of the "rock", high ash fuels can assist in the desulfurization process, partially offsetting some of the limestone and/or lime injection requirement. The Red Hills CFB facility in Choctaw MS was observed to capture about 35% of SO<sub>2</sub> in fuel (lignite) simply from the alkalie content of its high ash fuel. The fabric filter for a CFB boiler is designed to accommodate wide variations in particulate loading with little or no effect on its outlet emission rate. Fabric filters are routinely specified and guaranteed to meet a constant grain/dry standard cubic feet (gr/DSF) outlet emission rate. As inlet particulate loading increases, the bags may require more frequent cleaning, but are guaranteed to meet their permitted output emission rate regardless of variations in inlet loading. Thus, the permitted allowable emission rate of total filterable particulate, and by extension, HAP metals which are a subset of total filterable particulate, would be unaffected by substituting washed coal for ROM coal at the VHEC.

Based on these analyses, coupled with USEPA's conclusion that the MACT Floor for the coal-fired EGU source category should not mandate use of "perceived better fuels", it was concluded that coal washing is not demonstrated to result in lower overall HAP emissions from multi-fuel CFB boilers.

# 7.2 Thermal Pre-treatment

Thermal pre-treatment processes are specific to western coals, and no references were found suggesting that they would be effective, have been demonstrated, or would provide benefits for Virginia bituminous coals. These coal pretreatment technologies were evaluated as possible MACT pollution prevention strategies. Demonstration scale thermal pretreatment processes and their reduced-mercury coal products are undergoing pre-commercial evaluation at several Western power plants. These processes heat the coal to about 500° F, causing moisture to evaporate and mercury to volatilize. From the Literature, two potential pre-combustion mercury reduction techniques were identified, both of which involve thermal treatment of coal to drive off mercury; "K-Fuel" by KFx and the "Western Research Institute process". It has been reported that thermal pretreatment volatilizes 60–80% of mercury in PRB or ND lignite coals. While these processes are designed to remove mercury, it is claimed that they may also evaporate 60–70% of the moisture contained in these Western coal types and therefore raise their heating value by 30–40% while reducing NO<sub>x</sub> emissions by 20–30% as seen in pilot-scale test burns.

# 7.2.1 K-Fuel

K-Fuel <sup>™</sup> - In this process developed by KFx, crushed coal is heated to 500° F under 500 psi pressure for 45 minutes. K-Fuel is presently manufactured at a 750,000-ton per- year plant in Wyoming and sold for test purposes. Two full-scale plants treating 4 and 8 million tons-per-year, respectively, are scheduled for construction in Wyoming's PRB mining district. KFx also has developed an in-line K-Fuel system for installation at individual power plants, similar to the WRI process described below.

#### 7.2.2 Western Research Institute

Western Research Institute (WRI) – In this experimental two-stage thermal pretreatment process. Crushed coal is heated to 250° F to evaporate moisture, then to 500° F to volatilize mercury. Designed to be implemented onsite at a power plant, this process feeds coal directly into the boiler.

Thermal pretreatment processes for PRB coal have been demonstrated at pilot- and full-scale by their developers. Electric Power Research Institute (EPRI) is currently seeking host sites for a large test burn of K-Fuel and participants in a DOE-cosponsored pilot-scale test of the WRI process.

# 7.2.3 Cost of Thermal Pre-Treatment

While highly speculative since no commercial process has yet been constructed or operated, and since thermal treatment is touted as being effective for PRB and lignite fuels, an initial estimate for thermal coal treatment to achieve 50–70% mercury reduction in PRB and lignite coals is \$10–\$20/ton coal processed. This translates to \$120,000 – \$170,000/lb of mercury removed (500 MWe plant, 0.65 capacity factor, 275 lb/yr mercury emissions). These processes have never been demonstrated on a commercial scale, and are not considered to be "available " technologies for purposes of case-by-case MACT for the VCHEC. Further, it is unknown and undemonstrated if their use would result in any lower Hg emission rate for VCHEC, which is already well below the MACT Floor for the best controlled similar multi-fuel CFB.

# 7.2.4 Thermal Treatment of PRB and Lignite

Thermal treatment of coal is determined to not represent a case-by-case MACT applicable pollution prevention strategy for the proposed VCHEC. This technology is still in its developmental stage, and has not been applied commercially to any similar multi-fuel CFB. It is a technology being targeted for PRB and Lignite applications – no evidence was provided that it has ever been demonstrated for waste coal or for ROM Virginia coal. There is also no evidence that a lower Hg limit has been, or could be demonstrated in practice for any unit remotely similar to the VCHEC CFB's burning Virginia ROM and Waste Coals. The proponents of these technologies are not marketing them for such applications.

Finally, it is clear that the Hg driven from the coal by heating has to go somewhere, presumably to be captured in another air pollution control device at the pretreatment plant. It is doubtful that this secondary emission source would be as well controlled as what will be required as case-by-case MACT for the VCHEC multi-fuel CFB boilers.

# 8.0 Characterization of Hg, HCl, HF, Non-mercury Metals and Organic HAPs

USEPA has proposed a MACT Floor for Hg, and continuous compliance with enforceable permit limits has been achieved in practice by other sources for Hg, HCl, Pb (as a PSD pollutant) and HF. The HAP metals and organic HAPs have been regulated as part of total PM/PM<sub>10</sub> or VOC. Additional characterization of these hazardous air pollutants is provided in this section.

# 8.1 Mercury

Mercury is a naturally occurring element in coal and wood. At the temperatures expected in the VCHEC boilers, all of the mercury in the fuels will volatilize. CFB boilers are inherently low emitters of mercury emissions due to the typically high ash fuels. High ash fuels tend to generate a higher carbon content in the ash than pulverized coal units. Relatively high carbon content in the ash results in higher carbon on the fabric filters. Carbon adsorbs mercury which is then retained in the ash. In addition to these properties of the CFB, Dominion is proposing to also install activated carbon injection (ACI) to further reduce mercury emissions. The Virginia City Hybrid Energy Center will be the first CFB boilers in the United States to install ACI.

This combination of controls is more stringent than the best controlled similar sources as no other similar source has installed ACI. Dominion will monitor Hg emissions with a continuous emissions monitoring system (CEMS) to demonstrate continuous compliance.

# 8.2 Acid Gas HAPs (HCI and HF)

Chloride and fluoride emissions from CFB boilers result from the reaction of fuel-bound chlorides and fluorides in the combustion process. The fuel-bound chlorides and fluorides are hydrogenated during combustion producing hydrogen chloride (HCI) and hydrogen fluoride (HF). Dominion proposes the use of the combination of limestone injection in the CFB boiler and introduction of alkaline material in the dry flue gas desulfurization (FGD) to control HCl and HF emissions.

This combination of controls is as stringent as the controls currently used by the best similar source and therefore is considered MACT for both HCl and HF. Dominion will conduct initial and periodic performance tests to demonstrate compliance with the HCl and HF emission limits established by the VADEQ. The bases for the HCl and HF emissions are discussed in the following sections.

# 8.2.1 Hydrogen Chloride

Hydrogen chloride emissions will be controlled using the combination of limestone injection in the CFB boiler and introduction of alkaline material in the dry FGD system. Secondary HCl will also occur due to

the unreacted lime collected in the filter media on the fabric filter bags. The HCl emissions are based on the maximum anticipated chlorine content in the design coal of 1,000 ppmw and the removal efficiency of the SO<sub>2</sub> control system (a good indicator of effective acid gas neutralization) of 98%. The resulting HCl emission factor is 0.0026 lb/MMBtu.

# 8.2.2 Hydrogen Fluoride

Hydrogen fluoride emissions will be controlled using the combination of limestone injection in the CFB boiler and introduction of alkaline material in the dry FGD system. Secondary HF removal will also occur due to the unreacted lime collected in the filter media on the fabric filter bags. The HF emissions are based on the maximum anticipated fluorine content in the design coal of 890 ppmw and an estimated removal efficiency of the control system of 99.6%. The resulting HF emission factor is 0.00047 lb/MMBtu.

# 8.3 Non-mercury HAP Metals

The other HAP metals will be controlled in the same manner as particulate matter by using a fabric filter baghouse. This particulate control device is considered BACT for particulate emissions from coal-fired boilers, especially in light of the higher efficiencies achieved for fine particulate. As USEPA has indicated for other source categories, particulate emissions are an effective surrogate in lieu of establishing standards for the individual metals. Based on use of particulate as surrogate for other HAP metals, the estimated control efficiency of the combined technologies is expected to be in excess of 99%.

The potential emissions of HAP metals were estimated using procedures defined in "Study of Hazardous Air Pollutant Emissions from Electric Utility Stem Generating Units – Final Report to Congress," U.S. EPA, February 1998. These procedures allow for the estimation of emission factors for each HAP metal based on the coal type and location (i.e., Virginia bituminous coal), boiler type (i.e., circulating fluidized bed boiler), and specific add-on controls (i.e., dry FGD in combination with fabric filter). Therefore, these procedures can provide a HAP metal emission factor for the typical regional coal, specific boiler type, and control technologies proposed for the Project.

Because the proposed controls are as effective as those applied to the best similar source, fabric filtration is considered MACT for the other HAP metals. Dominion determined emission limits for individual HAP metals, based on the particulate emission limit as a surrogate for other trace metal emissions. The potential HAP metal emissions and estimated removal efficiencies are summarized in Table 3. The bases for the individual HAP metal emissions then is discussed in the following sections.

Table 3: Bases for HAP Metal Emissions from the Proposed CFB Boilers

HAP Metal	Concentration in Coal (ppmw) <sup>a</sup>	Removed with Bed Ash (%)	Removed in SDA/FF (%)	Removed Overall (%)	Emission Factor (lb/MMBtu) <sup>a</sup>	Hourly Emissions (lb/hr) <sup>b</sup>	Annual Emissions (tpy) <sup>c</sup>
Antimony*	0.93	0.00	99.70	99.70	4.07E-07	0.0026	0.01
Arsenic	11.00	33.00	99.80	99.87	2.18E-06	0.0136	0.060
Beryllium*	1.66	44.00	99.90	99.94	3.14E-07	0.00197	0.0083
Cadmium*	0.05	77.00	96.00	99.08	9.73E-08	0.00061	0.0025
Chromium	12.50	54.00	98.00	99.08	1.48E-05	0.093	0.41
Cobalt	6.30	0.00	99.90	99.90	8.10E-07	0.0051	0.022
Lead	61.0	0.00	99.90	99.90	7.84E-06	0.0491	0.215
Manganese*	19.00	37.00	99.80	99.87	5.04E-06	0.032	0.13
Mercury	0.35	0.00	98.00	98.00	9.01E-07	0.0056	0.0247
Nickel	11.20	33.00	99.00	99.33	9.64E-06	0.060	0.26
Selenium	2.70	16.00	99.00	99.16	2.91E-06	0.018	0.080

<sup>\*</sup> Emissions represent operation on 80% coal / 20% wood mix as AP-42 emission factors were higher on a lb/mmBtu basis for wood combustion than coal combustion.

# **Antimony**

Antimony is an impurity in both coal and wood. The potential emissions of antimony compounds from coal combustion are based on an arsenic concentration of 0.93 ppmw in Virginia bituminous coal as listed in the 1998 EPA Document. Based on the modified AP-42 emission factor, it is assumed that 100% of the antimony in the coal is entrained in the flue gas leaving the CFB unit. Further, the modified AP-42 emission factors assume that 99.7% of the antimony in the flue gas is removed in the spray dryer/fabric filter system. Therefore, approximately 99.7% of the antimony in the coal is assumed to be removed in the combustion system prior to discharge of the flue gas to the atmosphere. AP-42 has a higher antimony emission factor for wood combustion than for coal combustion. As such, maximum antimony emissions are based on the maximum wood combustion scenario of 20% (and 80% coal combustion). The resulting antimony emission factor is 4.07 x 10<sup>-7</sup> lb/MMBtu. We are unaware of any PSD permits issued for coal/wood-fired boilers that include emission limits for this HAP metal.

#### **Arsenic**

The potential emissions of arsenic compounds are based on an arsenic concentration of 11.0 ppmw in Virginia bituminous coal as listed in the 1998 EPA Document. Based on the modified AP-42 emission factor, it is assumed that approximately 33% of the arsenic is retained in the bed ash, with the remaining 67% entrained in the flue gas leaving the CFB unit. Further, the modified AP-42 emission factors assume that 99.8% of the arsenic in the flue gas is removed in the spray dryer/fabric filter system. Therefore, approximately 99.9% of the arsenic in the coal is assumed to be removed in the combustion system prior

Based on fuel composition and control factors cited in "Study of Hazardous Air Pollutant Emissions from Electric Utility Stem Generating Units – Final Report to Congress," U.S. EPA, February 1998.

b Based on the maximum heat input rate of 6,264 MMBtu/hr.

<sup>&</sup>lt;sup>c</sup> Based on the maximum heat input rate and 8,760 hr/yr.

to discharge of the flue gas to the atmosphere. The resulting arsenic emission factor is 2.18 x 10<sup>-6</sup> lb/MMBtu. We are unaware of any PSD permits issued for coal-fired boilers that include emission limits for this HAP metal.

# Beryllium

Beryllium is an impurity in both coal and wood. The potential emissions of beryllium compounds from coal combustion are based on a beryllium concentration of 1.66 ppmw in Virginia bituminous coal as listed in the 1998 EPA Document. Based on the modified AP-42 emission factor, it is assumed that approximately 44% of the beryllium is retained in the bed ash, with the remaining 56% entrained in the flue gas leaving the CFB unit. Further, the modified AP-42 emission factors assume that 99.9% of the beryllium in the flue gas is removed in the spray dryer/fabric filter system. Therefore, over 99.9% of the beryllium in the coal is assumed to be removed in the combustion system prior to discharge of the flue gas to the atmosphere. AP-42 has a higher beryllium emission factor for wood combustion than for coal combustion. As such, maximum beryllium emissions are based on the maximum wood combustion scenario of 20% (and 80% coal combustion). The resulting beryllium emission factor is 3.14 x 10<sup>-7</sup> lb/MMBtu. Because beryllium is a HAP regulated under 40 CFR Part 61, PSD permits have been issued by various agencies for coal or wood-fired boilers that include emission limits for this HAP metal.

#### Cadmium

Cadmium is an impurity in both coal and wood. The potential emissions of cadmium compounds from coal combustion are based on a cadmium concentration of 11.0 ppmw in Virginia bituminous coal as listed in the 1998 EPA Document. Based on the modified AP-42 emission factor, it is assumed that approximately 77% of the cadmium is retained in the bed ash, with the remaining 23% entrained in the flue gas leaving the CFB unit. Further, the modified AP-42 emission factors assume that 96.0% of the cadmium in the flue gas is removed in the spray dryer/fabric filter system. Therefore, approximately 99.1% of the cadmium in the coal is assumed to be removed in the combustion system prior to discharge of the flue gas to the atmosphere. AP-42 has a higher cadmium emission factor for wood combustion than for coal combustion. As such, maximum cadmium emissions are based on the maximum wood combustion scenario of 20% (and 80% coal combustion). The resulting cadmium emission factor is 9.73 x 10<sup>-8</sup> lb/MMBtu. We are unaware of any PSD permits issued for coal or wood-fired boilers that include emission limits for this HAP metal.

#### Chromium

The potential emissions of chromium compounds are based on a chromium concentration of 12.4 ppmw in Virginia bituminous coal as listed in the 1998 EPA Document. Based on the modified AP-42 emission factor, it is assumed that approximately 54% of the chromium is retained in the bed ash, with the

remaining 46% entrained in the flue gas leaving the CFB unit. Further, the modified AP-42 emission factors assume that 98.0% of the chromium in the flue gas is removed in the spray dryer/fabric filter system. Therefore, approximately 99.1% of the chromium in the coal is assumed to be removed in the combustion system prior to discharge of the flue gas to the atmosphere. The resulting chromium emission factor is 1.48 x 10<sup>-5</sup> lb/MMBtu. We are unaware of any PSD permits issued for coal-fired boilers that include emission limits for this HAP metal.

# Cobalt

The potential emissions of cobalt compounds are based on a cobalt concentration of 11.0 ppmw in Virginia bituminous coal as listed in the 1998 EPA Document. Based on the modified AP-42 emission factor, it is assumed that 100% of the cobalt in the coal is entrained in the flue gas leaving the CFB unit. Further, the modified AP-42 emission factors assume that 99.9% of the cobalt in the flue gas is removed in the spray dryer/fabric filter system. Therefore, approximately 99.9% of the cobalt in the coal is assumed to be removed in the combustion system prior to discharge of the flue gas to the atmosphere. The resulting cobalt emission factor is 8.10 x 10<sup>-7</sup> lb/MMBtu. We are unaware of any PSD permits issued for coal-fired boilers that include emission limits for this HAP metal.

#### Lead

The potential emissions of lead compounds are based on a lead concentration of 61.0 ppmw in Virginia bituminous coal as listed in the 1998 EPA Document. Based on the modified AP-42 emission factor, it is assumed that 100% of the lead in the coal is entrained in the flue gas leaving the CFB unit. Further, the modified AP-42 emission factors assume that 99.9% of the lead in the flue gas is removed in the spray dryer/fabric filter system. Therefore, approximately 99.9% of the lead in the coal is assumed to be removed in the combustion system prior to discharge of the flue gas to the atmosphere. The resulting lead emission factor is 7.84 x 10<sup>-6</sup> lb/MMBtu. Because lead is a criteria pollutant, permits have been issued by various agencies for coal-fired boilers that include emission limits for this HAP metal.

# Manganese

Manganese is an impurity in both coal and wood. The potential emissions of manganese compounds from coal combustion are based on a manganese concentration of 19.0 ppmw in Virginia bituminous coal as listed in the 1998 EPA Document. Based on the modified AP-42 emission factor, it is assumed that approximately 37% of the manganese is retained in the bed ash, with the remaining 63% entrained in the flue gas leaving the CFB unit. Further, the modified AP-42 emission factors assume that 99.8% of the manganese in the flue gas is removed in the spray dryer/fabric filter system. Therefore, approximately 99.9% of the manganese c in the coal is assumed to be removed in the combustion system prior to discharge of the flue gas to the atmosphere. AP-42 has a higher manganese emission factor for wood

combustion than for coal combustion. As such, maximum manganese emissions are based on the maximum wood combustion scenario of 20% (and 80% coal combustion). The resulting manganese emission factor is 5.04 x 10<sup>-6</sup> lb/MMBtu. We are unaware of any PSD permits issued for coal or wood-fired boilers that include emission limits for this HAP metal.

# Mercury

Mercury is an impurity in both coal and wood. The potential mercury emissions are based on a mercury coal concentration of 0.35 ppmw in Virginia bituminous coal. Based on this coal mercury content and a combined 98% removal efficiency from the CFB and ACI, it is estimated that facility's resulting Hg emission factor will be 9.01 x 10-7 lb/MMBtu. We are unaware of any other CFB boiler that uses ACI to control mercury.

#### Nickel

The potential emissions of nickel compounds are based on a nickel concentration of 11.2 ppmw in Virginia bituminous coal as listed in the 1998 EPA Document. Based on the modified AP-42 emission factor, it is assumed that approximately 33% of the nickel is retained in the bed ash, with the remaining 67% entrained in the flue gas leaving the CFB unit. Further, the modified AP-42 emission factors assume that 99.0% of the nickel in the flue gas is removed in the spray dryer/fabric filter system. Therefore, approximately 99.3% of the nickel in the coal is assumed to be removed in the combustion system prior to discharge of the flue gas to the atmosphere. The resulting nickel emission factor is 9.64 x 10<sup>-6</sup> lb/MMBtu. We are unaware of any PSD permits issued for coal-fired boilers that include emission limits for this HAP metal.

# Selenium

The potential emissions of selenium compounds are based on a selenium concentration of 11.2 ppmw in Virginia bituminous coal as listed in the 1998 EPA Document. Based on the modified AP-42 emission factor, it is assumed that approximately 16% of the selenium is retained in the bed ash, with the remaining 84% entrained in the flue gas leaving the CFB unit. Further, the modified AP-42 emission factors assume that 99.0% of the selenium in the flue gas is removed in the spray dryer/fabric filter system. Therefore, approximately 99.3% of the selenium in the coal is assumed to be removed in the combustion system prior to discharge of the flue gas to the atmosphere. The resulting selenium emission factor is 2.91 x 10<sup>-6</sup> lb/MMBtu. We are unaware of any PSD permits issued for coal-fired boilers that include emission limits for this HAP metal.

# 8.4 Organic HAPS

Organic HAP emissions include volatile, semi-volatile, and condensable organic compounds either present in the coal or formed as a product of incomplete combustion. Organic emissions are primarily characterized by the criteria pollutant class of unburned vapor-phase hydrocarbons. These emissions include alkanes, alkenes, aldehydes, alcohols, and substituted benzenes (*e.g.*, benzene, toluene, xylene, and ethyl benzene). The remaining organic emissions are composed largely of compounds emitted from combustion sources in a condensed phase. These compounds can almost exclusively be classed into a group known as polycyclic organic matter. Polycyclic organic matter is more prevalent in the emissions from coal combustion because of the more complex structure of coal.

Organic HAP emissions will be controlled by means of combustion control used to limit carbon monoxide (CO) and volatile organic compound (VOC) emissions. In general, a combustion control system seeks to maintain the proper conditions to ensure complete combustion through one or more of the following operation design features: providing sufficient excess air, staged combustion to complete burn out of products of incomplete combustion, sufficient residence time, and good mixing. Circulating fluidized bed coal-fired boilers are designed specifically for efficient fuel combustion with thorough mixing and residence time at temperature, plus staged combustion. The organic HAPs will be further controlled by the activated carbon injected into the flue gas upstream of the fabric filter baghouse. The organic HAPs will be adsorbed by the activated carbon collected in the filter media collected on the fabric filter bags. The USEPA has indicated for other source categories, VOC emissions are an effective surrogate in lieu of establishing control standards for the individual organic compounds.

The potential emissions of trace organic compounds were based on the emission factors cited in Section 1.1, Bituminous and Sub-bituminous Coal Combustion, of "Compilation of Air Pollutant Emission Factors," U.S. EPA Document No. AP-42, Fifth Edition, September 1998. Although the AP-42 emission factors are expressed in terms of pounds of pollutant per unit mass of coal fired (lb/ton), they should be normalized to pounds of pollutant per unit heat input (lb/MMBtu) to estimate organic emissions from different types of boilers firing various types of coal. Most appropriately, the emission factors should be normalized using the heating value of the coal fired during the individual tests conducted to derive each emission factor. The coal fired during most of these tests was bituminous coal with a heating value ranging from 10,000 to 12,500 Btu/lb. To estimate the organic emissions from the proposed CFB boilers, we conservatively assumed that the coal had a heating value of 7,782 Btu/lb.

The proposed control for volatile organic HAPs is as stringent as that applied to the emission controls achieved in practice by the best-controlled similar source and therefore is considered MACT. Rather than establish emission limits for individual organic HAPs, Dominion proposes that the VOC emission limit be used as a surrogate for organic emissions. The potential organic HAP emissions are summarized in Table 4. The bases for the organic HAP emissions then are discussed in the following sections.

Table 4: Bases for Volatile Organic HAP Emissions from the Proposed VCHEC CFB **Boilers** 

Organic HAP	Emission Factor (lb/ton) <sup>a</sup>	Emission Factor (Ib/MMBtu) <sup>b</sup>	Hourly Emissions (lb/hr) <sup>c</sup>	Annual Emissions (tpy) <sup>d</sup>	
Acetaldehyde*	NA	4.39E-05	0.27	1.10	
Acetophenone	1.50E-05	9.64E-07	0.006	0.026	
Acrolein*	NA	7.47E-04	4.68	20.4	
Benzene	1.30E-03	8.35E-05	0.52	2.3	
Benzyl Chloride	7.00E-04	4.50E-05	0.28	1.2	
Bis(2-ethylhexyl)phthalate	7.30E-05	4.69E-06	0.029	0.13	
Bromoform	3.90E-05	2.51E-06	0.016	0.069	
Carbon Disulfide	1.30E-04	8.35E-06	0.052	0.23	
Carbon Tetrachloride**	NA	9.08E-06	0.057	0.25	
2-Chloroacetophenone	7.00E-06	4.50E-07	0.0028	0.012	
Chlorobenzene*	NA	7.91E-06	0.050	0.213	
Chloroform*	NA	8.91E-06	0.056	0.234	
Cumene	5.30E-06	3.41E-07	0.0021	0.0093	
Cyanide	2.50E-03	1.61E-04	1.01	4.4	
2,4-Dinitrotoluene	2.80E-07	1.80E-08	0.00011	0.00049	
Dimethyl Sulfate	4.80E-05	3.08E-06	0.019	0.085	
Ethyl Benzene*	NA	1.17E-05	0.073	0.30	
Ethyl Chloride	4.20E-05	2.70E-06	0.017	0.074	
Ethylene Dibromide	1.20E-06	7.71E-08	0.0005	0.002	
Ethylene Dichloride	4.00E-05	2.57E-06	0.016	0.071	
Formaldehyde*	NA	6.84E-05	0.428	1.83	
Hexane	6.70E-05	4.30E-06	0.027	0.12	
Isophorone	5.80E-04	3.73E-05	0.23	1.02	
Methyl Bromide	1.60E-04	1.03E-05	0.064	0.28	
Methyl Chloride	5.30E-04	3.41E-05	0.21	0.93	
Methyl Ethyl Ketone	3.90E-04	2.51E-05	0.16	0.69	
Methyl Hydrazine	1.70E-04	1.09E-05	0.068	0.30	
Methyl Methacrylate	2.00E-05	1.29E-06	0.0080	0.035	
Methyl Tert Butyl Ether	3.50E-05	2.25E-06	0.014	0.06	
Methylene Chloride	2.90E-04	1.86E-05	0.12	0.51	
Naphthalene**	NA	3.65E-08	0.0002	0.001	
4-Nitrophenol**	NA	2.28E-08	0.0001	0.0006	
Phenol	1.60E-05	1.03E-06	0.0064	0.028	
Propionaldehyde**	NA	3.42E-05	0.21	0.87	
2378 TCDD**	NA	1.72E-12	1.08E-08	4.71E-08	
Tetrachloroethylene	4.30E-05	2.76E-06	0.017	0.076	
Toluene	2.40E-04	1.54E-05	0.097	0.42	
1,1,1-Trichloroethane	2.00E-05	1.29E-06	0.008	0.035	
2,4,6-Trichlorophenol**	NA	4.34E-09	2.72E-05	1.19E-04	
Styrene*	NA	3.73E-04	2.34	10.24	
Xylenes*	NA	7.04E-06	0.044	0.187	
Vinyl Acetate	7.60E-06	4.88E-07	0.0031	0.013	
Vinyl Chloride**	NA	3.73E-04	0.023	0.101	

Emissions represent operation on 80% coal / 20% wood mix as AP-42 emission factors were higher on a lb/mmBtu basis for wood combustion than coal combustion.

<sup>\*\*</sup>AP-42 lists an emission factor for this pollutant for wood combustion but not coal combustion.

Based on the emission factors cited in Section 1.1, Bituminous and Sub-bituminous Coal Combustion, of U.S. EPA Document No. AP-42, Fifth Edition, September 1998.

Based on the higher heating value of the design coal of 7,782 Btu/lb.

Based on the maximum heat input rate of 6,264 MMBtu/hr.

Based on the maximum heat input rate and 8,760 hr/yr.

# Acetaldehyde

The largest source of acetaldehyde is the photochemical oxidation of other compounds in the atmosphere. Acetaldehyde is also a product of incomplete combustion of fossil fuels and wood. AP-42 has a higher acetaldehyde emission factor for wood combustion than for coal combustion on a lb/mmBtu basis. As such, maximum acetaldehyde emissions are based on the maximum wood combustion scenario of 20% (and 80% coal combustion). The resulting acetaldehyde emission factor is 4.39 x 10<sup>-5</sup> lb/MMBtu for the proposed CFB boilers.

# Acetophenone

Acetophenone is a crystalline ketone that is used as a solvent for cellulose ethers and esters in the manufacture of alcohol-soluble resins. Acetophenone is also a product of incomplete combustion of fossil fuels. The AP-42 emission factor for acetophenone released from coal combustion is  $1.50 \times 10^{-5}$  lb/ton, which is equivalent to  $9.64 \times 10^{-7}$  lb/MMBtu for the proposed CFB boilers.

#### Acrolein

Acrolein is a product of incomplete combustion of fossil fuels and wood and decomposes quickly in the atmosphere through reaction with other chemicals from exposure to sunlight. AP-42 has a higher acrolein emission factor for wood combustion than for coal combustion on a lb/mmBtu basis. As such, maximum acrolein emissions are based on the maximum wood combustion scenario of 20% (and 80% coal combustion). The resulting acrolein emission factor is 7.47 x 10<sup>-4</sup> lb/MMBtu for the proposed CFB boilers.

# Benzene

The largest source of benzene is losses from gasoline storage tanks, evaporative losses during gasoline refilling, and releases to from leaking underground storage tanks. Benzene is also a product of incomplete combustion of fossil fuels. The AP-42 emission factor for benzene released from coal combustion is  $1.30 \times 10^{-3}$  lb/ton, which is equivalent to  $8.35 \times 10^{-5}$  lb/MMBtu for the proposed CFB boilers.

# **Benzyl Chloride**

Sources of benzyl chloride include the manufacture of pharmaceuticals, certain dyes, perfume, and flavor products. Benzyl chloride is also a product of incomplete combustion of fossil fuels. The AP-42 emission factor for benzyl chloride released from coal combustion is 7.00 x 10<sup>-4</sup> lb/ton, which is equivalent to 4.50 x 10<sup>-5</sup> lb/MMBtu for the proposed CFB boilers.

# Bis(2-ethylhexyl)phthalate

The primary stationary sources of bis(2-ethylhexyl)phthalate are manufacturers of furniture and fixtures, as

well as lumber and wood products. Bis(2-ethylhexyl)phthalate is also a product of incomplete combustion of fossil fuels. The AP-42 emission factor for bis(2-ethylhexyl)phthalate released from coal combustion is 7.30  $\times$  10<sup>-5</sup> lb/ton, which is equivalent to 4.69  $\times$  10<sup>-6</sup> lb/MMBtu for the proposed CFB boilers.

# Bromoform

The tropical oceans are the primary source of reactive bromine to the atmosphere in the form of short-lived brominated methanes, such as bromoform and dibromomethane. Bromoform is also a product of incomplete combustion of fossil fuels. The AP-42 emission factor for bromoform released from coal combustion is  $3.90 \times 10^{-5}$  lb/ton, which is equivalent to  $2.51 \times 10^{-6}$  lb/MMBtu for the proposed CFB boilers.

#### Carbon Disulfide

Carbon disulfide is a natural product of anaerobic biodegradation and is released to the atmosphere from oceans and coastal and marshland areas of high biological activity. Carbon dioxide is also a product of incomplete combustion of fossil fuels. The AP-42 emission factor for carbon disulfide released from coal combustion is  $1.30 \times 10^{-4}$  lb/ton, which is equivalent to  $8.35 \times 10^{-6}$  lb/MMBtu for the proposed CFB boilers.

#### **Carbon Tetrachloride**

Carbon tetrachloride has been used in the production of refrigeration fluid and propellants for aerosol cans, as a pesticide, as a cleaning fluid and degreasing agent, in fire extinguishers, and in spot removers. Carbon tetrachloride is a product of incomplete combustion of wood. The AP-42 emission factor for carbon tetrachloride weighted for the coal / wood fuel mix is 9.08 x 10<sup>-6</sup> lb/MMBtu for the proposed CFB boilers.

# 2-Chloroacetophenone

The primary uses for 2-chloroacetophenone are in tear gas and in chemical Mace.

2-chloroacetophenone is also a product of incomplete combustion of fossil fuels. The AP-42 emission factor for 2-chloroacetophenone released from coal combustion is  $7.00 \times 10^{-6}$  lb/ton, which is equivalent to  $4.50 \times 10^{-7}$  lb/MMBtu for the proposed CFB boilers.

# Chlorobenzene

The primary sources of chlorobenzene are crude petroleum and natural gas extraction, plastic materials and synthetics manufacturing, and petroleum refining. It is also used as a solvent in pesticide formulations, in degreasing, and other industrial applications. Chlorobenzene is also a product of incomplete combustion of fossil fuels and wood. AP-42 has a higher chlorobenzene emission factor for wood combustion than for coal combustion on a lb/mmBtu basis. As such, maximum chlorobenzene emissions are based on the maximum wood combustion scenario of 20% (and 80% coal combustion). The resulting chlorobenzene emission factor is 7.91 x 10<sup>-6</sup> lb/MMBtu for the proposed CFB boilers.

#### Chloroform

Chloroform results of the chlorination of naturally occurring organic materials found in raw water supplies; hence, water treated with chlorine may be contaminated with trace amounts of chloroform. Chloroform is also a product of incomplete combustion of fossil fuels and wood. AP-42 has a higher chloroform emission factor for wood combustion than for coal combustion on a lb/mmBtu basis. As such, maximum chloroform emissions are based on the maximum wood combustion scenario of 20% (and 80% coal combustion). The resulting chloroform emission factor is 8.91 x 10<sup>-6</sup> lb/MMBtu for the proposed CFB boilers.

#### Cumene

The primary sources of cumene are oil refiners, chemical industry, plastics manufacturing, pulp and paper mills, and various manufacturing plants. Other sources include oil spills, commercial and household painting and paint, and varnish and lacquer removal. Cumene is also a product of incomplete combustion of fossil fuels. The AP-42 emission factor for cumene released from coal combustion is  $5.30 \times 10^{-6}$  lb/ton, which is equivalent to  $3.41 \times 10^{-7}$  lb/MMBtu for the proposed CFB boilers.

# Cyanide

The primary sources of cyanide are chemical processing facilities, steel and iron industries, and petroleum refineries. Cyanide is also a product of incomplete combustion of fossil fuels. The AP-42 emission factor for cyanide released from coal combustion is  $2.50 \times 10^{-3}$  lb/ton, which is equivalent to  $1.61 \times 10^{-4}$  lb/MMBtu for the proposed CFB boilers.

# 2,4-Dinitrotoluene

2,4-Dintirotoluene is used as an intermediate in the manufacture of polyurethanes. 2,4-Dinitrotoluene is also a product of incomplete combustion of fossil fuels. The AP-42 emission factor for 2,4-dinitrotoluene released from coal combustion is  $2.80 \times 10^{-7}$  lb/ton, which is equivalent to  $1.80 \times 10^{-8}$  lb/MMBtu for the proposed CFB boilers.

# **Dimethyl Sulfate**

Dimethyl sulfate is used as an industrial methylating agent for amines and phenols. The primary sources of dimethyl sulfate are research and testing facilities. Dimethyl sulfate is also a product of incomplete combustion of fossil fuels. The AP-42 emission factor for acetaldehyde released from coal combustion is  $4.80 \times 10^{-5}$  lb/ton, which is equivalent to  $3.08 \times 10^{-6}$  lb/MMBtu for the proposed CFB boilers.

#### Dioxins / Furans

Dioxins and furans are formed as an unintentional by-product of incomplete combustion. They may be released to the environment during the combustion of fossil fuels and wood, and during the incineration of municipal and industrial wastes. AP-42 has an emission factor for total polychlorinated dibenzo-p-dioxins and polychlorinated dibenzofurans from coal combustion of  $2.44 \times 10^{-7}$  lbs/ton which is equivalent to  $1.57 \times 10^{-8}$  lbs/MMBtu for the proposed CFB boilers.

# **Ethyl Benzene**

Sources of ethyl benzene include petroleum processing facilities and industrial facilities using the chemical as part of their manufacturing process. Ethyl benzene is also a product of incomplete combustion of fossil fuels and wood. AP-42 has a higher ethyl benzene emission factor for wood combustion than for coal combustion on a lb/mmBtu basis. As such, maximum ethyl benzene emissions are based on the maximum wood combustion scenario of 20% (and 80% coal combustion). The resulting ethyl benzene emission factor is 1.17 x 10<sup>-5</sup> lb/MMBtu for the proposed CFB boilers.

# **Ethyl Chloride**

The primary sources of ethyl chloride include release from factories that manufacture or use ethyl chloride and evaporation from some landfills, solvents, refrigerants, and anesthetics. Ethyl chloride is also a product of incomplete combustion of fossil fuels. The AP-42 emission factor for ethyl chloride released from coal combustion is  $4.20 \times 10^{-5}$  lb/ton, which is equivalent to  $2.70 \times 10^{-6}$  lb/MMBtu for the proposed CFB boilers.

# **Ethylene Dibromide**

Ethylene dibromide was used primarily as an additive to leaded gasoline and as a fumigant. Ethylene dibromide is currently used in the treatment of felled logs for bark beetles and termites, and control of wax moths in beehives. Ethylene dibromide is also a product of incomplete combustion of fossil fuels. The AP-42 emission factor for ethylene dibromide released from coal combustion is 1.2 x 10<sup>-6</sup> lb/ton, which is equivalent to 7.71 x 10<sup>-8</sup> lb/MMBtu for the proposed CFB boilers.

# **Ethylene Dichloride**

The primary sources of ethylene dichloride are chemical manufacturers, manufacturers of aircraft and parts, and manufacturers of medical instruments and supplies. Ethylene dichloride is also a product of incomplete combustion of fossil fuels. The AP-42 emission factor for ethylene dichloride released from coal combustion is  $4.00 \times 10^{-5}$  lb/ton, which is equivalent to  $2.57 \times 10^{-6}$  lb/MMBtu for the proposed CFB boilers.

# Formaldehyde

The primary sources of formaldehyde are emissions from building materials, consumer products, and fabrics containing the chemical. Formaldehyde is also a product of incomplete combustion of fossil fuels and wood. AP-42 has a higher formaldehyde emission factor for wood combustion than for coal combustion on a lb/mmBtu basis. As such, maximum formaldehyde emissions are based on the maximum wood combustion scenario of 20% (and 80% coal combustion). The resulting formaldehyde emission factor is 6.84 x 10<sup>-5</sup> lb/MMBtu for the proposed CFB boilers.

#### Hexane

Hexane is released from oil refineries, plastics industries, and chemical plants, as well as service stations, gasoline storage tanks, and various adhesives, paints, and paint thinners. Hexane is also a product of incomplete combustion of fossil fuels. The AP-42 emission factor for hexane released from coal combustion is  $6.70 \times 10^{-6}$  lb/ton, which is equivalent to  $4.30 \times 10^{-6}$  lb/MMBtu for the proposed CFB boilers.

# Isophorone

Isophorone primarily is used as a solvent for concentrated vinyl chloride/acetate-based coating systems for metal cans, other metal paints, nitrocellulose finishes, and printing inks for plastics. It is also used in some herbicide and pesticide formulations and in adhesives for plastics, polyvinylchloride, and polystyrene materials. Isophorone is also a product of incomplete combustion of fossil fuels. The AP-42 emission factor for isophorone released from coal combustion is 5.80 x 10<sup>-4</sup> lb/ton, which is equivalent to 3.66 x 10<sup>-5</sup> lb/MMBtu for the proposed CFB boilers.

# **Methyl Bromide**

Methyl bromide primarily is used in the control of pest insects, weeds, pathogens, and rodents. It is used in agriculture primarily for soil fumigation, as well as for commodity and quarantine treatment. Methyl bromide is also a product of incomplete combustion of fossil fuels. The AP-42 emission factor for methyl bromide released from coal combustion is  $1.60 \times 10^{-4}$  lb/ton, which is equivalent to  $1.03 \times 10^{-5}$  lb/MMBtu for the proposed CFB boilers.

# **Methyl Chloride**

Methyl chloride primarily is used in the production of silicones where it is used to make methylate silicon. It is also used in the production of agricultural chemicals, methyl cellulose, quaternary amines, and butyl rubber. Methyl chloride is also a product of incomplete combustion of fossil fuels. The AP-42 emission factor for methyl chloride released from coal combustion is  $5.30 \times 10^{-4}$  lb/ton, which is equivalent to  $3.41 \times 10^{-5}$  lb/MMBtu for the proposed CFB boilers.

# Methyl Ethyl Ketone

The primary sources of methyl ethyl ketone include the chemical industry, semiconductor industry, heavy equipment manufacturing, and manufacturers of paints, inks, varnishes and lacquers. Other sources include commercial and household painting, varnish and lacquer removal, and consumer products containing this chemical. Methyl ethyl ketone is also a product of incomplete combustion of fossil fuels. The AP-42 emission factor for methyl ethyl ketone released from coal combustion is 3.90 x 10<sup>-4</sup> lb/ton, which is equivalent to 2.51 x 10<sup>-5</sup> lb/MMBtu for the proposed CFB boilers.

# **Methyl Hydrazine**

Methyl hydrazine is used as a chemical intermediate, a solvent, and as a missile propellant. It is also a product of incomplete combustion of fossil fuels. Methyl hydrazine is also a product of incomplete combustion of fossil fuels. Methyl hydrazine is also a product of incomplete combustion of fossil fuels. The AP-42 emission factor for methyl hydrazine released from coal combustion is 1.70 x 10<sup>-4</sup> lb/ton, which is equivalent to 1.09 x 10<sup>-5</sup> lb/MMBtu for the proposed CFB boilers.

# **Methyl Methacrylate**

The primary sources of methyl methacrylate are the chemical and plastics industry and the paints and coatings manufacturing industry. Other sources include vapors and spills of commercial and household paints. Methyl methacrylate is also a product of incomplete combustion of fossil fuels. The AP-42 emission factor for methyl methacrylate released from coal combustion is  $2.00 \times 10^{-5}$  lb/ton, which is equivalent to  $1.29 \times 10^{-6}$  lb/MMBtu for the proposed CFB boilers.

# Methyl Tert Butyl Ether

Methyl tert butyl ether or MTBE is primarily used a gasoline additive to oxygenate the fuel. MTBE is also used as a relatively inexpensive solvent. In addition, MTBE is a product of incomplete combustion of fossil fuels. The AP-42 emission factor for MTBE released from coal combustion is 3.5 x 10<sup>-5</sup> lb/ton, which is equivalent to 2.25 x 10<sup>-6</sup> lb/MMBtu for the proposed CFB boilers.

# Methylene Chloride

Methylene chloride is commonly used in paint removers and in various chemical processing operations. It also is employed in the production of flexible urethane foams, aerosol and adhesive formulations, and as a cleaning agent for fabricated metal parts. Methylene chloride is also a product of incomplete combustion of fossil fuels. The AP-42 emission factor for methylene chloride released from coal combustion is 2.90 x 10<sup>-4</sup> lb/ton, which is equivalent to 1.86 x 10<sup>-5</sup> lb/MMBtu for the proposed CFB boilers.

# Naphthalene

Naphthalene is an important parent material to produce numerous substitution products used in the manufacture of dyes, insecticides, organic solvents and synthetic resins. Naphthalene is the major raw material for Carbaryl, used as a general-purpose insecticide. Naphthalene is also used for moth repellents, fungicides, lubricants, explosives, wood preservatives, vermicides and hydronaphthalenes (tetralin, decalin). Naphthalene is also a product of incomplete combustion of wood. The AP-42 emission factor for naphthalene weighted for the coal / wood fuel mix is 3.65 x 10<sup>-8</sup> lb/MMBtu for the proposed CFB boilers.

# 4-Nitrophenol

4-Nitrophenol is used to manufacture drugs (e.g., acetaminophen), fungicides, methyl and ethyl parathion insecticides, and dyes and to darken leather. 4-Nitrophenol is also a product of incomplete combustion of wood. The AP-42 emission factor for 4-nitrophenol weighted for the coal / wood fuel mix is 2.28 x 10<sup>-8</sup> lb/MMBtu for the proposed CFB boilers.

#### Phenol

The primary sources of phenol are oil refineries, coal conversion plants, and municipal waste treatment plants. Phenol is also a product of incomplete combustion of fossil fuels and wood. AP-42 has a higher phenol emission factor for wood combustion than for coal combustion on a lb/mmBtu basis. As such, maximum phenol emissions are based on the maximum wood combustion scenario of 20% (and 80% coal combustion). The resulting phenol emission factor is 1.11 x 10<sup>-5</sup> lb/MMBtu for the proposed CFB boilers.

# Propionaldehyde

Propionaldehyde is used as a synthetic flavoring in non-alcoholic beverages and food. Other uses include disinfectants, as a preservative, and in agricultural chemical preparations. Propionaldehyde is also a product of incomplete combustion of fossil fuels as well as wood. As such, maximum propionaldehyde emissions are based on the maximum wood combustion scenario of 20% (and 80% coal combustion). The weighted propionaldehyde AP-42 emission factor for the coal / wood fuel mix is 3.42 x 10<sup>-5</sup> lb/MMBtu for the proposed CFB boilers.

#### Styrene

Sources of styrene include industrial process that use or manufacture the material or where it is formed as a by-product. Styrene is also a product of incomplete combustion of fossil fuels and wood. AP-42 has a higher styrene emission factor for wood combustion than for coal combustion on a lb/mmBtu basis. As such, maximum styrene emissions are based on the maximum wood combustion scenario of 20% (and 80% coal combustion). The resulting styrene emission factor is 3.73 x 10<sup>-4</sup> lb/MMBtu for the proposed CFB boilers.

# Tetrachloroethylene

The primary sources of tetrachloroethylene are dry cleaners, chemical plants, degreasing operations, and deinking operations. Other possible sources are paint, varnish and lacquer removal and consumer products containing the chemical. Tetrachloroethylene is also a product of incomplete combustion of fossil fuels. The AP-42 emission factor for tetrachloroethylene released from coal combustion is  $4.30 \times 10^{-6}$  lb/ton, which is equivalent to  $2.76 \times 10^{-6}$  lb/MMBtu for the proposed CFB boilers.

# Toluene

The primary sources of toluene are oil refiners, chemical industry, metal degreasing, printing operations, and manufacturers of paints, varnishes and lacquers. Other sources include vapors and spills of gasoline, commercial and household painting, and paint, varnish and lacquer removal. Toluene is also a product of incomplete combustion of fossil fuels. The AP-42 emission factor for toluene released from coal combustion is  $2.40 \times 10^{-4}$  lb/ton, which is equivalent to  $1.54 \times 10^{-5}$  lb/MMBtu for the proposed CFB boilers.

# 1,1,1-Trichloroethane

1,1,1-trichloroethane is an excellent solvent for many organic materials. It was used for cleaning metal parts and circuit boards, as a photoresist solvent in the electronics industry, as an aerosol propellant, as a cutting fluid additive, and as a solvent for inks, paints and adhesives, and other coatings. 1,1,1-trichloroethane is also a product of incomplete combustion of fossil fuels. The AP-42 emission factor for 1,1,1-trichloroethane released from coal combustion is  $2.0 \times 10^{-5}$  lb/ton, which is equivalent to  $1.29 \times 10^{-6}$  lb/MMBtu for the proposed CFB boilers.

# 2,4,6-Trichlorophenol

2,4,6-Trichlorophenol is used as a wood and glue preservative, and in leather tanning and finishing. It is also a product of incomplete combustion of wood. AP-42 has an emission factor for 2,4,6-Trichlorophenol for wood combustion only (not coal). As such, maximum 2,4,6-Trichlorophenol emissions are based on the maximum wood combustion scenario of 20% (and 80% coal combustion). The emission factor for wood combustion weighted over the coal / wood fuel mix is  $4.34 \times 10^{-9}$  lb/MMBtu for the proposed CFB boilers.

# **Xylenes**

The primary sources of xylenes are the chemical and petroleum industries and manufacturers of paints, dyes, and lacquers. Xylenes are also products of incomplete combustion of fossil fuels and wood. AP-42 has a higher xylene emission factor for wood combustion than for coal combustion on a lb/mmBtu basis. As such, maximum xylene emissions are based on the maximum wood combustion scenario of 20% (and 80% coal combustion). The resulting xylene emission factor is 7.04 x 10<sup>-6</sup> lb/MMBtu for the proposed CFB boilers.

# **Vinyl Acetate**

The primary sources of vinyl acetate are manufacturers of miscellaneous chemical products, including adhesive and sealant, lumber and wood products, and concrete, gypsum, and plaster products. Vinyl acetate is also a product of incomplete combustion of fossil fuels. The AP-42 emission factor for vinyl acetate released from coal combustion is  $7.60 \times 10^{-6}$  lb/ton, which is equivalent to  $4.88 \times 10^{-7}$  lb/MMBtu for the proposed CFB boilers.

# **Vinyl Chloride**

Vinyl chloride is used to make polyvinyl chloride (PVC) plastic and vinyl products. It is also a product of incomplete combustion of wood. AP-42 has an emission factor for vinyl chloride for wood combustion only (not coal). As such, maximum vinyl chloride emissions are based on the maximum wood combustion scenario of 20% (and 80% coal combustion). The emission factor for wood combustion weighted over the coal / wood fuel mix is  $3.73 \times 10^{-4}$  lb/MMBtu for the proposed CFB boilers.

# 7.0 MACT Limit Compliance

To provide for monitoring of proposed MACT standards, Dominion proposes to install, calibrate, maintain, and operate a CEMS or operate a sorbent trap monitoring system to measure the concentration of mercury in the exhaust gases from each CFB boiler, in accordance with 40 CFR 60.49Da(q) for mercury. Dominion has not identified any other multi-fuel CFB that has demonstrated continuous compliance with an enforceable Hg emission limit using continuous monitoring, and this element of the proposed case-by-case MACT goes beyond the MACT Floor. Dominion proposes to conduct initial and periodic compliance tests for HCl and HF to demonstrate compliance with the corresponding emission limits established by the VADEQ. For HAP metals, Dominion proposes that the PM emission limit be used as a surrogate for trace metal emissions. Likewise, Dominion proposes that the VOC emission limit be used as a surrogate for organic HAP. Final periodic monitoring, recordkeeping, and testing requirements for the surrogates PM and VOC will be determined in the final PSD permit. As a precedent for this approach, the Kentucky DAQ allows for the use of filterable PM as a surrogate for HAP metals and VOC as a surrogate for organic HAPs in the PSD permit issued for Unit 3 at the Hugh L. Spurlock Generating Station.

# 8.0 Similar Sources Emissions Comparison

Below is a table (Table 5) of HAP emission limits from similar sources for comparison purposes to the VCHEC. The table includes emission limits for PM (surrogate for inorganic HAPs except Hg), CO and VOC (surrogates for organic HAPs), HCl, HF, and Hg, as well as specific organic or inorganic HAP emission limits, if any.

Table 5: Comparison of Similar Sources to VCHEC (lbs/mmBtu)

Project	PM	co	VOC	HCI	HF	Hg	As	Be	Pb
VCHEC	0.012	0.15	0.005	0.0026	0.00047	9.0 E-07	NA	NA	NA
AES Puerto Rico	0.015	0.10	0.0047	NA	0.0005	NA	NA	NA	NA
Grant Town Power Plant	0.03	0.17	0.008	NA	0.00068	1.8E-05	NA	8.18E-08	1.22E-04
Greene Energy	0.015	0.20	0.005	0.0067	0.0014	2.1E-06	NA	5.2E-05	1.3E-01
Morgantown <sup>a</sup>	0.03	0.157	0.0074	NA	0.00053	0.00136	2.7E-06	2.7E-07	1.7E-04
North Branch	0.03	0.17	0.005	NA	0.00054	1.75E-05	NA	1.5E-07	7.96E-06
River Hill	0.03	0.20	0.005	0.0034	0.0014	NA	NA	1.1E-03	1.4E-03
Robinson Power Beech Hollow	0.012	0.15	0.006	NA	NA	2.9E-03	NA	NA	1.40E-02
Scrubgrass	0.030	NA	0.005	0.10	NA	NA	NA	NA	NA
Seward	0.010	0.15	0.005	0.15	NA	NA	NA	NA	NA
Spurlock 3	0.015	0.15	0.0036	0.15	0.00047	2.65E-06	NA	1.46E-05	6.30E-06
Spurlock 4	0.012	0.10	0.002	NA	0.000047 <sup>b</sup>	2.1E-06	NA	NA	NA
Western Greenbrier	0.030	NA	0.20	0.00147	0.00205	2.1E-06	NA	NA	

Some of the emission limits are listed in lb/hr units. Equivalent lb/mmBtu emission rates are listed in the table for comparison purposes. The actual emission limits are HF-0.4 lbs/hr, Hg-1.021 lbs/hr, As-0.002 lbs/hr, Be-0.0002 lbs/hr, and Pb-0.13 lbs/hr.

b We believe that the Spurlock 4 HF emission limit is an error. The corresponding lb/hr HF limit correlates to 0.00047 lbs/mmBtu which is equivalent to the Spurlock 3 HF emission

limit.

Step 1 of the MACT analysis is to identify the best controlled similar source and to determine the emission control achieved in practice by that source. This is often referred to as the "MACT floor". The best controlled similar source depends on the pollutant in question. As has been stated in this document and it is important to reiterate, reductions in certain pollutants result in increases of other pollutants, i.e. lower CO or VOC emissions result in higher NOx emissions.

# PM

PM emissions are considered for the purposes of MACT as a surrogate for inorganic HAPs. VCHEC is proposing to use fabric filters as the control technology which is widely recognized as the control device that delivers maximum particulate control for a CFB. A review of the PM emission limits shows that Reliant Seward has the lowest PM emission limit of 0.010 lbs/mmBtu. The facility has been unable to demonstrate compliance with this emission limit. Of the nine stack test runs conducted at the Reliant Seward facility (six by the Pennsylvania Department of Environmental Protection, three by Reliant), all six PADEP stack test runs were above 0.010 lbs/mmBtu, all of them at least double the limit. The average of all nine tests is 0.038 lbs/mmBtu. As such, this limit has not been achieved in practice. It is therefore appropriate to consider VCHEC's proposed PM emission limit of 0.012 lbs/MMBtu as the lowest PM emission limit among similar sources.

# VOC

VOC emissions are considered for the purposes of MACT a surrogate for organic HAPs. VCHEC is proposing to use good combustion practices as the control technology for VOC emissions as add-on VOC controls are not appropriate for CFB boiler technology. A review of the VOC emission limits from Table 5 shows that AES Puerto Rico and Spurlock 3 and 4 have lower VOC emission limits than the proposed VOC emission limit for VCHEC. The AES Puerto Rico VOC limit is only marginally lower and the facility has a NOx limit that is over 40% higher than the VCHEC limit (0.07 lbs/mmBtu vs. 0.10 lbs/mmBtu). For this reason, AES Puerto Rico is not similar with regard to VOC emissions because decreasing VOC emissions results in increasing NOx emissions. Decreasing the VOC emissions is not possible for VCHEC. It is our understanding that Spurlock 3 has been unable to consistently meet their NOx emission limit (same as VCHEC's NOx limit). This has the affect of decreasing VOC and CO emissions. Dominion must maintain compliance with its NOx emission limit and consequently, the VCHEC's VOC and CO emissions would be slightly higher than those at Spurlock 3. The Spurlock 4 unit is not operational, and as such, the VOC limit has not been achieved in practice. Given this information, it is appropriate to conclude that the VOC emission rate of 0.005 lbs/mmBtu represents MACT.

# <u>CO</u>

Similar to VOC, CO emissions may be considered for the purposes of MACT as a surrogate for organic HAPs. VCHEC is proposing to use good combustion practices as the control technology for CO

emissions as add-on CO controls are not appropriate for CFB boiler technology. A review of the CO emission limits shows that AES Puerto Rico and Spurlock 4 are the only facilities with lower CO emission limits (0.10 lbs/mmBtu) than the VCHEC. AES Puerto Rico has a NOx limit that is over 40% higher than the VCHEC limit (0.07 lbs/mmBtu vs. 0.10 lbs/mmBtu). For this reason, AES Puerto Rico is not similar with regard to CO emissions because decreasing CO emissions result in increasing NOx emissions. The VCHEC could not operate at this low CO emission limit and meet the proposed NOx limit. The Spurlock 4 unit is not operational, and as such, the CO limit has not been achieved in practice.

#### HCI

Hydrogen chloride emissions will be controlled using the combination of limestone injection in the CFB boiler and introduction of alkaline material in the dry FGD system. Secondary HCl will also occur due to the unreacted lime collected in the filter media on the fabric filter bags. These controls represent the control technologies that limit acid gases to the maximum extent possible for CFB technology. Inspection of the table shows that the only facility with a lower HCl limit than the proposed limit for VCHEC is Western Greenbier (0.00147 vs. 0.0026). The HCl emissions at VCHEC are based on the maximum anticipated chlorine content in the design coal of 1,000 ppmw and the removal efficiency equivalent to the SO<sub>2</sub> control system (a good indicator of effective acid gas neutralization) of 98%. The resulting HCl emission factor is 0.0026 lb/mmBtu. Western Greenbrier is not yet operational. As such, Western Greenbrier's HCl emission limit has not been demonstrated to be achieved in practice. Given the proposed control system at VCHEC and 98% control efficiency, it is appropriate to conclude that the HCl emission rate of 0.0026 lbs/mmBtu represents MACT.

# HF

Hydrogen fluoride emissions will be controlled using the combination of limestone injection in the CFB boiler and introduction of alkaline material in the dry FGD system. Secondary HF removal will also occur due to the unreacted lime collected in the filter media on the fabric filter bags. These controls represent the control technologies that limit acid gases to the maximum extent possible for CFB technology. Inspection of the table shows that the only facility with a lower HF emission limit than VCHEC is Spurlock 4 (0.00047 vs. 0.000047). As stated in the footnote on the table, we believe that the Spurlock 4 HF emission limit is an error. The corresponding lb/hr HF limit correlates to 0.00047 lbs/mmBtu which is equivalent to the Spurlock 3 HF emission limit. HF emission estimates from VCHEC are based on the maximum anticipated fluorine content in the design coal of 890 ppmw and an estimated removal efficiency of the control system of 99.6%. The resulting HF emission factor is 0.00047 lb/MMBtu. In light of the likely error in the Spurlock 4 HF emission limit, it is appropriate to conclude that the VCHEC HF emission rate of 0.00047 lbs/mmBtu represents MACT.

# Hg

Mercury emissions are controlled at a high rate due to the inherent properties of a CFB boiler (ability to burn high ash fuels which result in relatively high carbon content ash). VCHEC is proposing to also use ACI as an additional control technology which would make this the first CFB facility in the United States to install ACI for Hg control. Based on inspection of the table, VCHEC has the lowest Hg permit limit of all of the similar sources. As stated previously, it is not appropriate to infer that actual emission (stack test) data represents a basis for establishing a MACT Floor; as such spot tests are not continuously achievable under reasonably foreseeable worst-case conditions due to uncertainty and variability in fuels, control equipment operation and the conditions under which the data were collected. VCHEC will be required to demonstrate compliance with the Hg limit on a continuous basis using a Hg CEMS. As such, it is appropriate to conclude that 9.01 x 10<sup>-7</sup> lbs/MMBtu is representative of MACT for Hg emissions at the VCHEC.

# Other HAPs

Table 5 shows emission limits for arsenic, beryllium and lead for several other facilities. These three inorganic HAPs are a subset of the particulate matter. Dominion is proposing an emission limit that is the lowest PM emission limit among similar sources (with the exception of Reliant Seward who has failed six of their nine PM stack tests). It is; therefore, appropriate to conclude that the PM emission limit is sufficient in assuring that the inorganic HAP emissions are as low as any similar source. In addition, Dominion conducted air dispersion modeling on all HAP emissions and the results demonstrated that all of the HAP emissions were far below their respective Significant Ambient Air Concentrations.

Step 2 of the MACT analysis is referred to as "beyond-the-MACT-floor" and entails determining the maximum reduction in HAP emissions that the specific source, on a case-by-case basis, can achieve taking into consideration cost and non-air quality health and environmental impacts and energy requirements. Dominion is not aware of any available methods that could reduce HAP emissions at the VCHEC beyond what has been detailed in this section. There are no other known tail-end controls that are feasible for this type of application, nor has it been determined that using a higher BTU / low ash coal can reduce all of the HAP emissions, i.e. washed coal may increase some HAPs and reduce others.

In addition, using a washed coal poses adverse economic, energy and environmental affects. Washed coal is significantly more expensive than ROM coal. The process of washing coal demands energy (energy required to wash the coal at the preparation plant as well as increased transportation, not to mention carbon lost in the washing process). The wet process of washing coal uses significant amounts of water. Finally, washing coal may remove some metals by removing the rock material prior to combustion, but that material is still placed back into the environment in a waste pile or slurry

impoundment. In addition, the metals that are volatilized in the fuels are captured at a very high rate in the fabric filter and encapsulated in the ash. In summary, it is not appropriate for HAP emission limits to be set beyond the MACT floor in this case.